Evidence for an Astrophysical Event in the Pleistocene*

R.B. Firestone[†] and W. Topping[§]

Radiocarbon dating of Paleo-Indian artifacts in the northeastern United States and southeastern Canada has yielded some dates that are several thousand years younger than determined by comparison with similar artifacts known to date from about 12,000 years BP. In one instance the date from thermoluminescence was 12,360±1240 years BP while the radiocarbon date was 2880±175 years BP. Other anomalies associated with these artifacts lead us to propose that they could have been caused by some astrophysical event such as a meteor impact, solar flare, or supernova.

Etching of chert flakes found with the artifacts shows evidence of "particle-like tracks", at a density of 70,000 per cm^2, preferentially on one side. Chondrules are found in the chert and a large excess of small magnetic particles (50-200 microns) is found in the adjacent soil layer. Chert from more recent sites does not exhibit tracks, and the track density appears to decrease with distance from the central site in Michigan.

Artifacts from the Michigan site were analyzed by chemical separation and alpha counting for Pu concentration and found to contain about 20,000 time the normal amount of ^{239}Pu. They were also analyzed at the McMaster University reactor for ^{235}U content by delayed neutron counting and for ^{238}U by activation analysis. The $^{235}U/^{238}U$ ratios were about 1/3 higher than for natural uranium. Soils adjacent to the artifacts were also found to have similarly elevated $^{235}U/^{238}U$ ratios and showed evidence for elevated ^{137}Cs levels.

Various scenarios should be explored to explain these data. Perhaps the archaeological dating of the artifacts is flawed or the ^{14}C measurements were somehow contaminated. The particle tracks may be misidentified, and the micrometeorite concentration might be due to natural geological forces. ^{239}Pu and ^{137}Cs could be from natural fallout although the presence of ^{239}Pu in the rather impervious chert is remarkable. The $^{235}U/^{238}U$ ratios are unusual and such large discrepancies were not previously been reported.

Taken together, these results may be the signature of some astrophysical event at the time the artifacts were deposited. About 12,000 years BP the long history of ice ages came to an end and numerous species of plants and animals became extinct. For example all large herbivores in North America, including the mammoths, suddenly disappeared.

Perhaps there was an impact event, larger than Tanguska in 1908, that caused the anomalies. The Carolina Bays, 500,000 elliptical depressions whose major axes all point towards the area of interest, were formed at about the right time, possibly by a comet impact. But how would this cause the anomalies? Analysis of cosmogenic isotopes in lunar rocks indicate that a solar flare producing up to 5×10^{13} protons (>10 MeV)/cm^2 may have occurred within the past 20,000 years. Tree ring and ocean sediment ^{14}C data indicate elevated levels during the Pleistocene, consistent with enhanced cosmic-ray activity. Ice core data also show elevated ^{10}Be concentrations during the ice ages although they also correlate with ^{18}O variations, an indicator of temperature fluctuations. The normal solar cycle is correlated with large variations in the rate of solar energetic particles, so might some major solar event have created the anomalies? Could a nearby supernova, cosmic-ray jet, or explosion in the galactic center have caused them? Known supernovas have been detected in the tree ring record. Though continued measurements and a closer look at possible explanations we hope to explain these data.

Footnotes and References

* Research supported by the National Science Foundation and William Topping.

† Lawrence Berkeley National Laboratory

§ Baldwin, Michigan